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**The Next Generation FOQA Programs**

by

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# **The Next Generation FOQA Programs**

## **KEYWORDS**

Aviation

Use of in-flight recorded data for Flight Operational Quality Assurance

Flight Guidance

Cockpit Workload

## **INTRODUCTION**

The reason why the aircraft accident rate has stayed fairly flat since the mid-70' has caused many to speculate as to why. First of all, - is it at an acceptable level? or is "Zero Accidents" an attainable goal to strive for. We must always as an industry strive for "Zero Accidents".

The increase in traffic density over the next ten to fifteen years is bound to have an effect, not only on the rate, but the number of accidents. The numbers we are looking at are unacceptable.

What has kept the accident rate flat since the mid-70' is better flight training programs with the introduction of LOFT and Cockpit Resource Management programs. Introduction of GPWS and TCAS. The value that these programs have added to further reduce accidents has been exhausted as indicated by the persistent flat accident rate.

One of the yet un-exploited tools is Flight Operational Quality Assurance or FOQA.

The goal of FOQA programs is to provide airline managers with information that will enable them to better understand risks to flight operation and how to manage risk.

## **HISTORY**

Airlines in Europe (SAS, KLM, Swissair, BA and others) has done Flight Analysis since the

Mid 1970'. The first programs included reading data off the metal foil recorders, raw data from the early Flight Data Recorders containing from 5 to 30 parameters. The first QAR (Quick Access Recorders) which was really called a DAR (Digital Airborne Recorder) containing 200-300 parameters.

Why did the Europeans embark on, in those days, cumbersome data extraction? Foil recorder reading engraving through a microscope and process DAR tapes on mainframe computers only to get a limited benefit. The answer is very simple. They needed information.

## **INFORMATION**

As always the driver is an accident. In the mid 70' there was no CNN to show the horrors of an accident. The ones who suffered were the families of the victims. The airline and the manufactures of airframe and engines had their own problems. The airlines realized that they

needed an insight in the day-to-day operation. Terms like quality emerged. They need to “see it before you see it on CNN”.

The more information you have the better decisions you are able to make. Or we may even go as far as saying the more intelligence you have the better you are able to understand a problem and be proactive. Intelligence in a military sense is gathering of information. Comparing information, double-checking, looking for patterns and deviation (from peacetime) norm. Isn't that exactly what we want to do? Look for patterns, look for deviation from an established norm and finally do Risk Analysis.

FOQA programs use in-flight recorded data to determine the flight path of an aircraft from takeoff to landing. But, the real value of FOQA is turning the in-flight recorded data into meaningful and useful information. Information that evaluate and audit the quality of; flight training programs, standard operating procedures, quantifying risk, quality of management, ATC flight guidance, cockpit workload, etc.

Recovering of all in-flight recorded data is of the utmost importance. The devil is in the details. An exceedance detected is of no value unless you are able to determine what caused the exceedance. An engine event/exceedance is good information. The engine can be put on the alert list. But what you really want to know is the causal factor. What lead up to the event in the first place?

It is all in the in-flight recorded raw data.

Again, what is it that we really want to know? Is it just exceedance of a value under certain conditions. We will probably still look at exceedances as a source of information, but in a different light. First, it is not of interest to us during an approach when a limit is exceeded, but rather at what height above touchdown was the aircraft out of the “Gray” area again. We would also want to know what the pre-cursors were to the approach exceedance e.g. high approach speed and/or rate of descent. Pre-cursors could be ATC guidance of the flight or it could be an un-flyable approach procedure or it could be the environment inside the cockpit – a cockpit resource management (CRM) issue. Or high tailwind aloft could have caused a high-speed approach. By identifying pre-cursors and causal factors we have then come a long way, and it is all in the in-flight recorded data.

What we really want to know is the environment inside the cockpit. The human factors. Let's pause for a moment.

This is a big one.

We must assume that the pilots are well trained and that the pilots want to perform to the standards that they have been trained to. But the pilots can only guide the aircraft to the standards they have been trained to or as good as the performance of the autoflight system is and the information available.

Autoflight system altitude capture is a good example of poorly designed systems on some aircraft types. Who got blamed for altitude excursions – the pilots of course. It was not until the causal factors were uncovered in the in-flight recorded raw determined that it was a combination of design and software that caused the altitude busts. The system was not flyable or performing to specifications.

This paper discusses how in-flight recorded data may be used to determine cockpit environment and the cockpit workload for the crew. What inside and outside factors are influencing the cockpit workload and how can those factors be determined so that change to flight guidance can be made.

Safe flight guidance is a complex issue. It depends on ATC management, weather, complex takeoff or approach procedures due to terrain or noise abatement, the flight guidance system avionics and warning systems. What it boils down to is safe guidance of an aircraft with minimal risk.

By processing of in-flight recorded data that can provide information of the cockpit environment, adequate changes can be made to minimize risk and prevent accidents.

Human factor research is continuing with major advances being made in system safety and reliability. Accidents are caused less by failures of the machine and more by the performance failures of man. Is it possible to measure cockpit environment and workload?

Let's give it a try.

## **AlliedSignal FOQA II™**

AlliedSignal FOQA II™ is a next generation Flight Operational Quality Assurance program designed to provide useful and meaningful information to airline managers. FOQA II is an end to end hands-off fully automated software program designed to provide useful information to airline managers in flight operation, flight safety, flight training and engineering. Focus in the design has been to allow maximum time for the operators to do analysis and minimal time to operate the system. FOQA II is intended to be accessible on an airlines' network for optimum utilization of information by end-users. The system is expandable and designed to store all in-flight recorded data. This allows airlines to re-process the data under different search criteria. FOQA II consists of two main components: The Raw Data Processing System (RDPS) and the Decision Support System (DSS).

The Raw Data Processing is mainly a background program that takes care of all processing requirements.

The Decision Support System is a uniquely designed relational database system that allows for extraction of information such as “what-if” and queries of a large number of events stored in the system. FOQA II uses high fidelity visualization and simulation whenever feasible, to display a situation or an analysis. Visualization is 3-dimensional. The Visualization and Simulation can be

used to display and replay AlliedSignal Enhanced Ground Proximity Warning events using a photo realistic terrain database.

The database Risk Management System also assesses risk to flight operation on a daily basis and determines probability of reoccurrence of detected events. FOQA II determines Pre-Cursors, Atypicality and Risk Analysis (PAR).

### **AlliedSignal PAR™ (Pre-Cursors, Atypicality and Risk Analysis)**

This advanced type of analysis is in the development phase.

#### **Pre-Courser**

The purpose of Pre-Cursors to Event Determination is to be able to make change to procedures, training or ATC environment. As an example what are the pre-courser to an unstable approach to LAX RW 25R. “See it before you see it on CNN”.

#### **Atypicality**

The purpose of detecting atypical flights or flights that deviation from an established baseline norm is to identify flights that could end up as being a high risk approach. This technique will allow detection of flights that are deviating from normal operation, but not necessarily triggering pre-defined exceedance events. The baseline will be dynamically updated as part of the raw data processing. The base line norm can be used to evaluate procedures. Comparison of the actual baseline to standard operating procedures, e.g. at what point is the landing gear in the down and locked position. This can be done for all flights or one aircraft type, or approaches to a specific airport runway.

#### **Risk Analysis**

Risk Analysis is a process that includes Risk Assessment and Risk Management. Risk Assessment is identifying hazards to a flight that may lead to an accident or at some point during flight will cause an unwanted situation that may lead to an accident. Risk is characterized in qualitative or quantitative terms. This includes the probability of an occurrence. Risk management is the process within risk analysis that includes identifying, evaluating and implementing alternatives for mitigating risk.

#### **FOQA II Risk Index**

Airline managers must on a daily basis be kept abreast of the risk to the passengers and the fleet of aircraft being operated. FOQA II will provide the tools to do so by creating a Risk Index for each airport and runway based on flights flown over a period of time.

### **AlliedSignal CWI™ (Cockpit Workload Index)**

This program is in the development phase.

The AlliedSignal CWI™ creates an index for each approach flown to an airport and runway. Assessing flight guidance of the aircraft and crew actions in the cockpit needed to operate the aircraft. Each critical milestone is weighted based on criticality and time detected before actual touchdown on the runway the aircraft was set up to land on. By comparing CWI from different flights, it may be determined why cockpit workload is high under certain conditions.

How is this done? We need all the in-flight recorded raw data to determine what environment that the pilots have in the cockpit. The process could begin at 10,000' or FL100. That is where most airlines define the cockpit as sterile until parked at the gate. This is where the workload increases and risk is increased also. The CWI will be a compilation of certain milestones during the descent, approach and land phase. The milestones could be by actions by the pilots in connection with the guidance of the aircraft or could be maneuvering of the aircraft in accordance with instructions given to the autoflight system. Checklist items will also be determined as milestones. Are some checklist items performed late and shortly before touchdown? If the items are performed late this could be an indication of high workload or that something was not quite normal during the approach.

Milestones (routine event snapshots) typical examples:

- Abnormal switch position for phase of flight
- Late descent compared to distance/time to touchdown
- Late ILS localizer and/or glide slope capture or late turn onto final
- Large heading change below a specific height
- Low energy and high speed
- Late landing configuration of the aircraft
- Weather, turbulence, icing
- Abnormal configuration or any aircraft system fault configuration
- Abnormal high power setting for flight condition
- Unstable heading
- Checklist items late completion
- Missed approach and pull-up

The CWI will be available for analysis on a daily basis for each flight. The CWI will identify runways that have a high index value for further investigation. The analyst might look for contributing factors such as weather, time of day or traffic congestion. Or compare flights of similar high CWI and identify similarities.

## **CONCLUSIONS**

Information gathering for the purpose of doing airline risk management is a daunting task. Information is gathered to prevent certain events from happen.

The aviation industry is battling our friend Murphy. Recent technology advances allow us to more fully evaluate the man machine interface – the Human Factor.

High workload in a cockpit constitutes a high risk and high probability of an accident. When, due to high workload, the normal and trained interaction between the captain and co-pilot is degraded the risk of an accident can become unacceptably high. By analyzing flight guidance, determination may be made, why under certain conditions cockpit workload is high, determination of casual factors can be made and action through training, procedures and system design can be taken to prevent future accidents.

Can we afford not to, I think not!